US011517944B2

(12) **United States Patent**
Della Torre

(10) **Patent No.: US 11,517,944 B2**
(45) **Date of Patent: Dec. 6, 2022**

(54) **DEVICE FOR CLEANING CYLINDRICAL ROLLERS, MACHINE COMPRISING SAID DEVICE, AND CLEANING METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 266 days.

(21) Appl. No.: **16/720,451**

(22) Filed: **Dec. 19, 2019**

(65) **Prior Publication Data**

US 2021/0187566 A1 Jun. 24, 2021

(51) **Int. Cl.**

B41F 35/00	(2006.01)
B08B 7/04	(2006.01)
B08B 3/10	(2006.01)
B08B 1/00	(2006.01)
A46B 9/06	(2006.01)
A46B 13/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B08B 7/04*** (2013.01); ***A46B 9/06*** (2013.01); ***A46B 13/04*** (2013.01); ***B08B 1/002*** (2013.01); ***B08B 1/008*** (2013.01); ***B08B 3/10*** (2013.01); ***B41F 35/00*** (2013.01); *A46B 2200/30* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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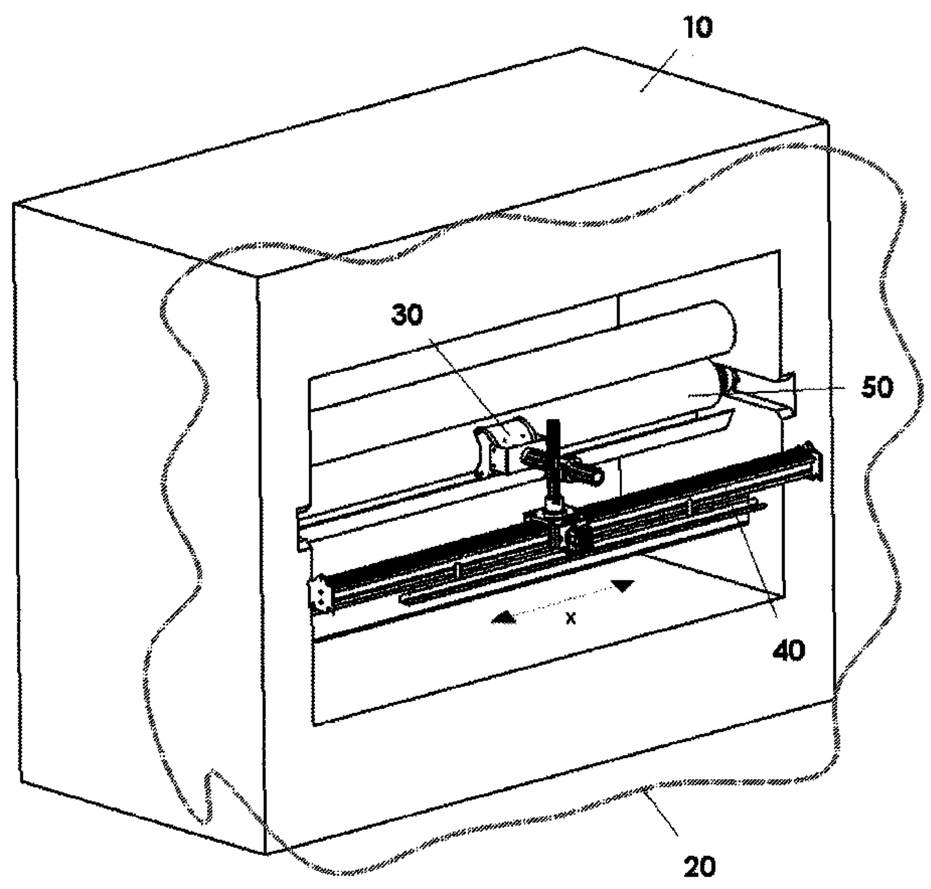
(57) **ABSTRACT**

The cleaning device (**20**) for cleaning a cylindrical roller (**50**), for example an anilox roller of a printing machine, includes a cleaning head (**30**) with a cleaning chamber (**110**), in which there is housed a mechanical cleaning member (**60**), and with which there are associated feeding members (**70**) for feeding a cleaning liquid into the cleaning chamber (**110**). The mechanical member (**60**) and cleaning liquid dispensed by the feeding members work in combination inside said cleaning chamber (**110**) to clean the lateral surface of the roller (**50**).

25 Claims, 14 Drawing Sheets



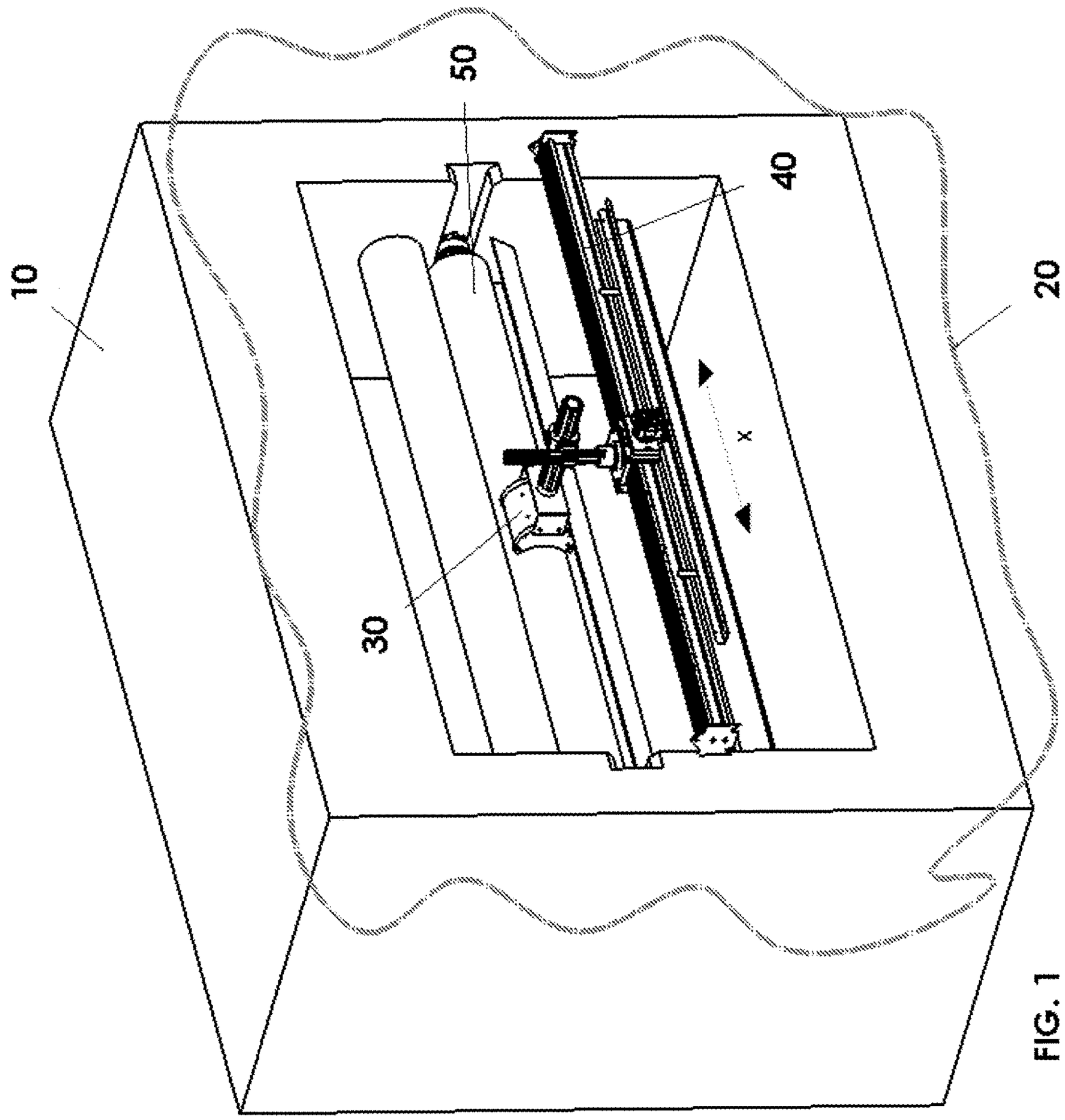


FIG. 1

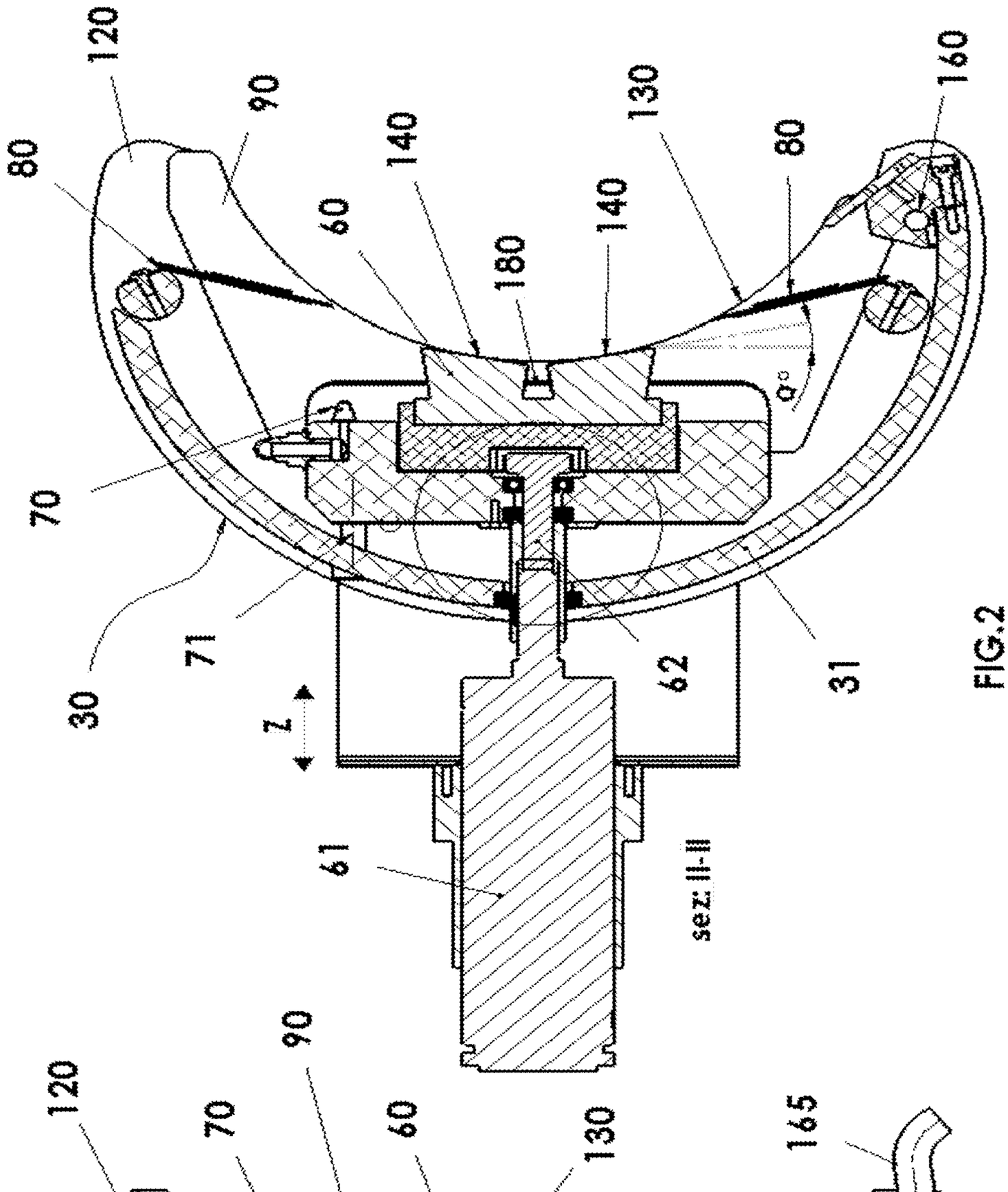
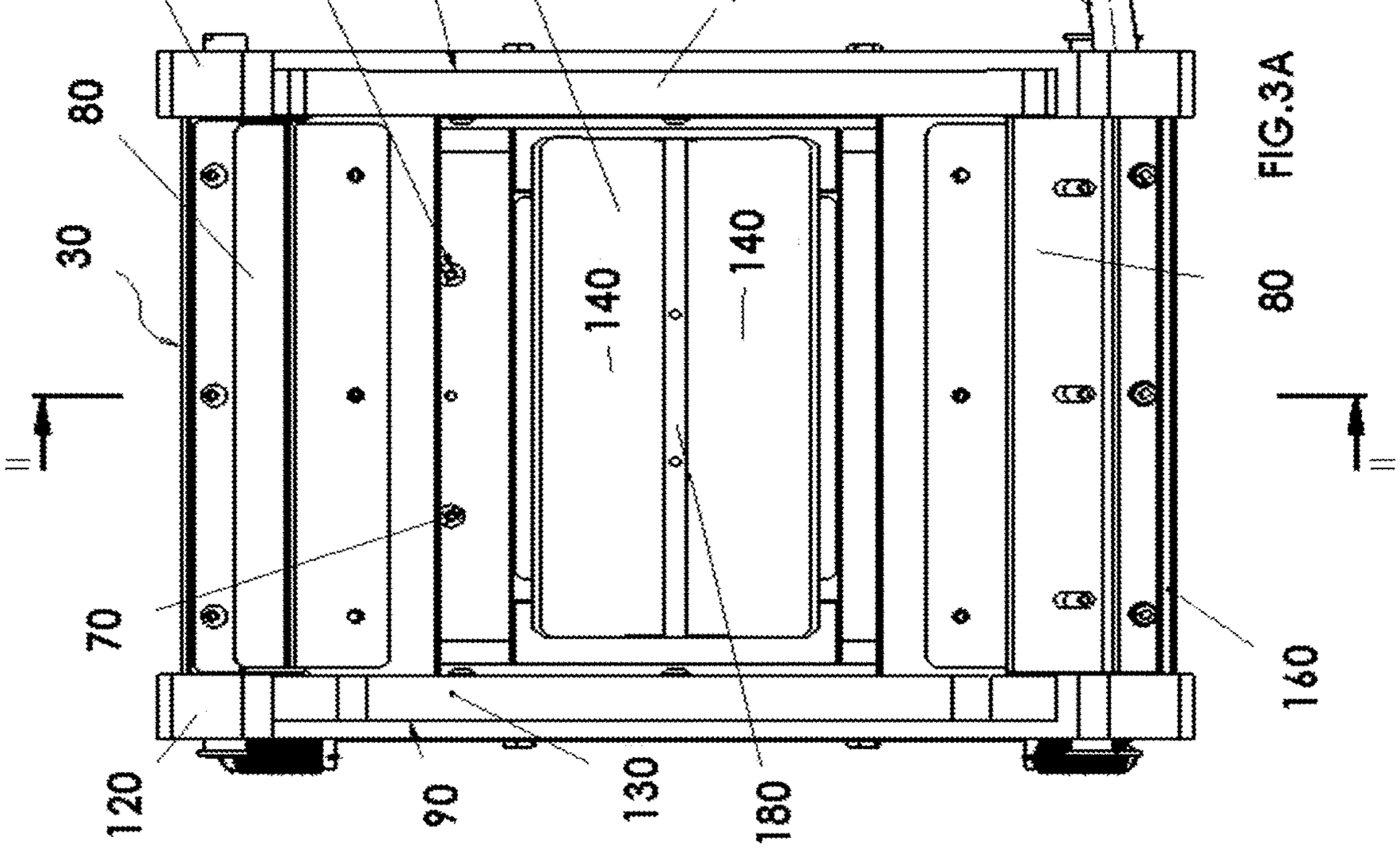

120
90
80
140
130
160
60
180
140
80
70
71
30
62
31
Z
61
sez. II-II

FIG.2


120
70
90
60
130
165
80
30
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70
120
90
130
180
80
160

FIG.3A

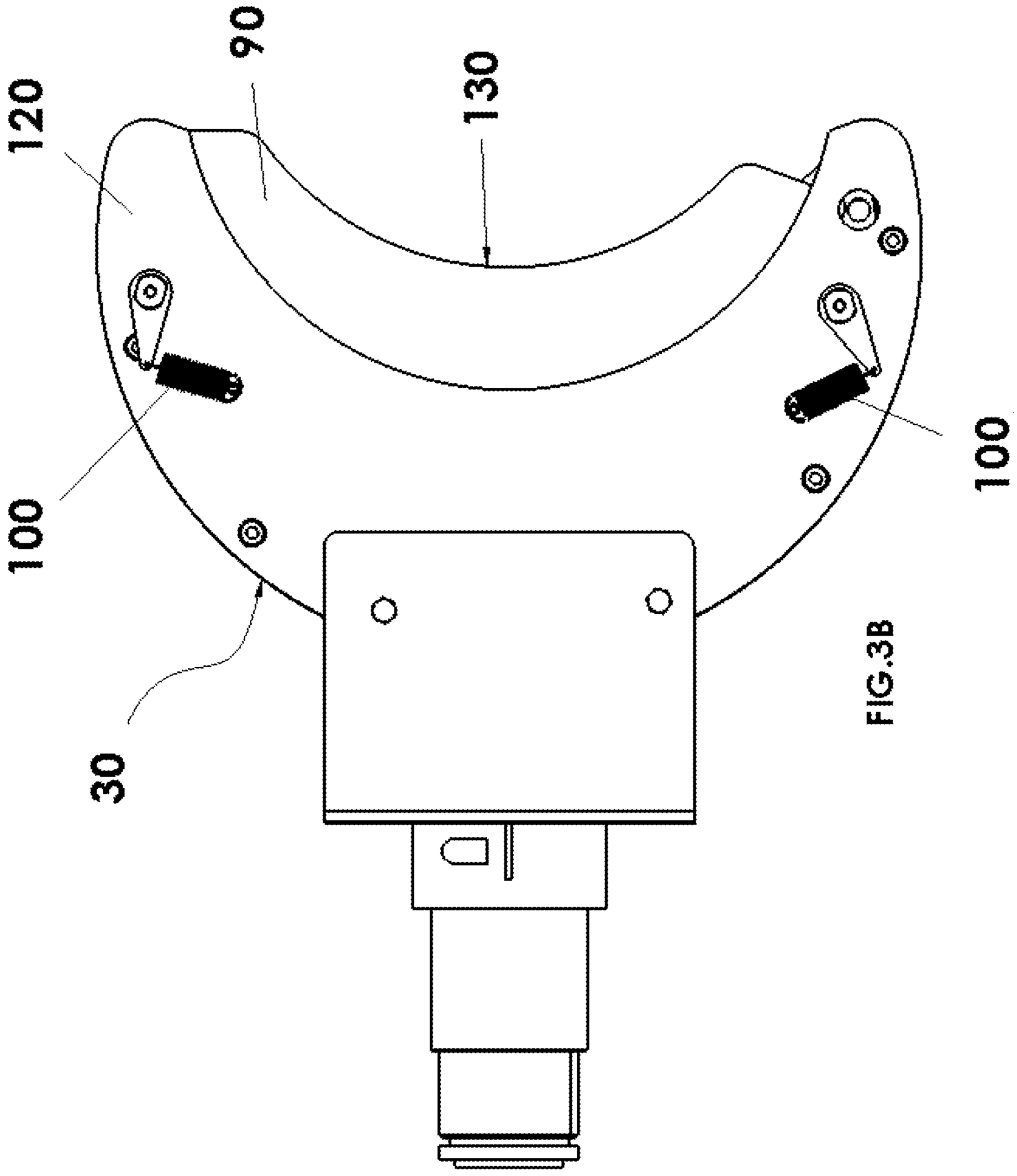
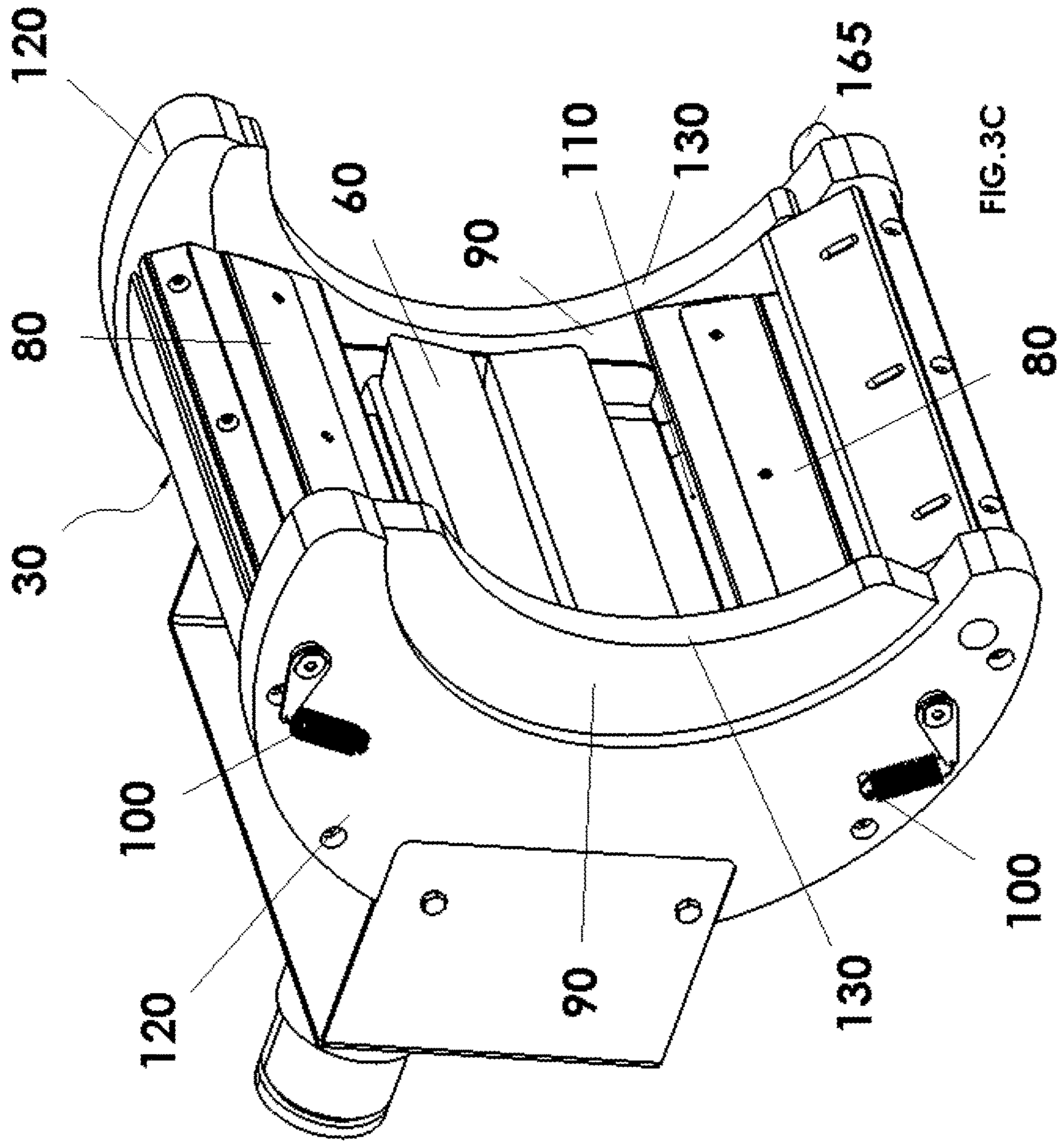


FIG.3B



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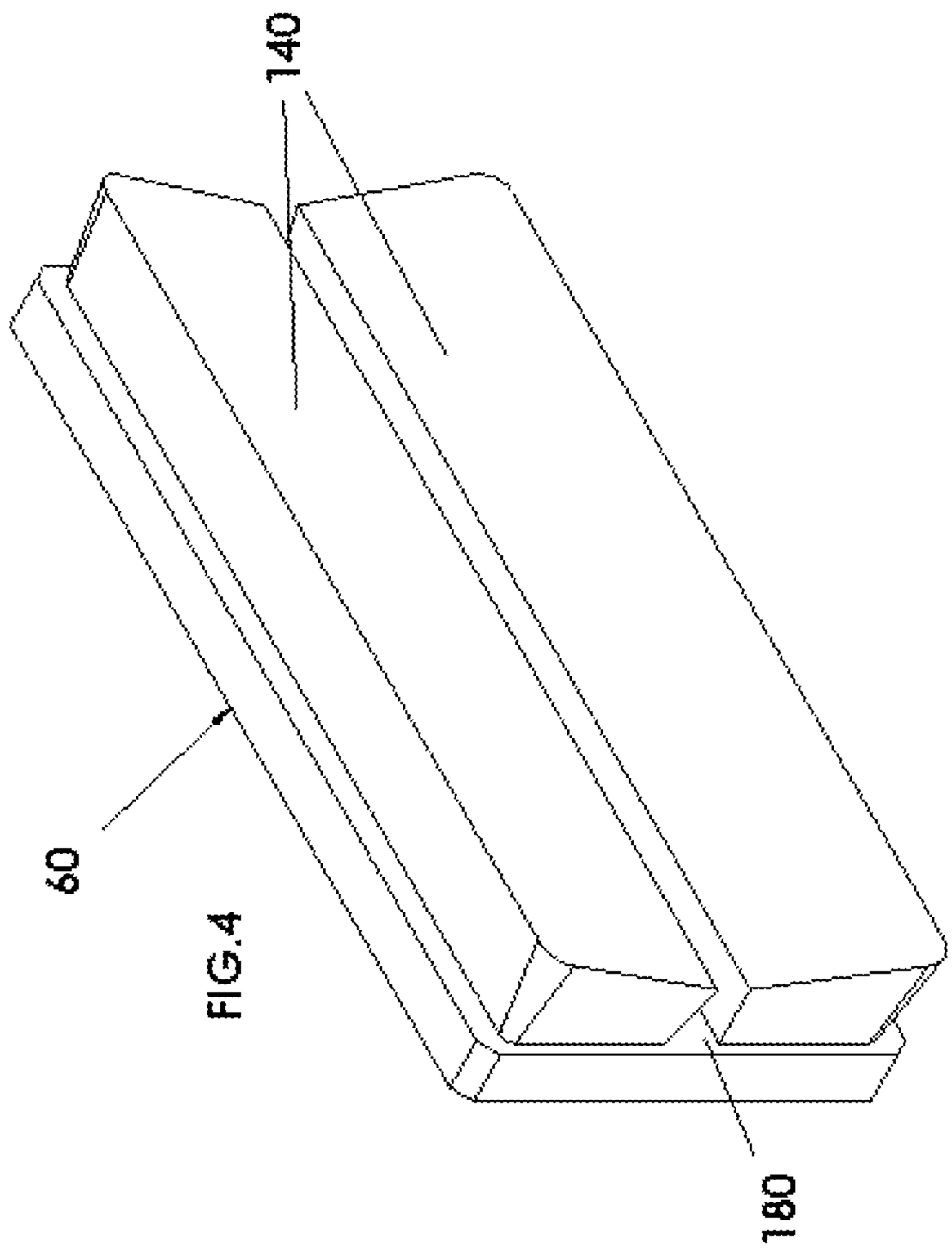


FIG.4

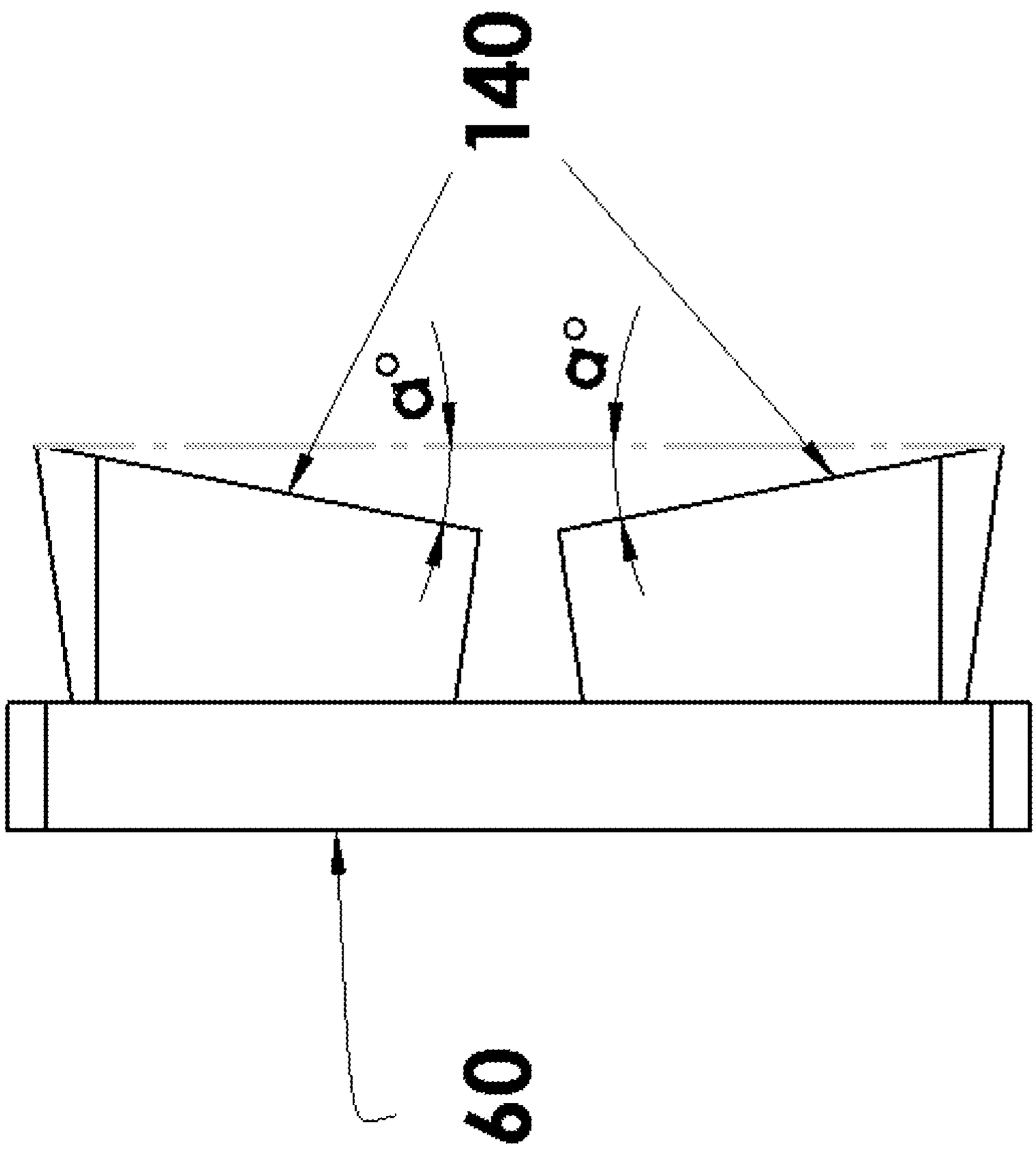


FIG.5

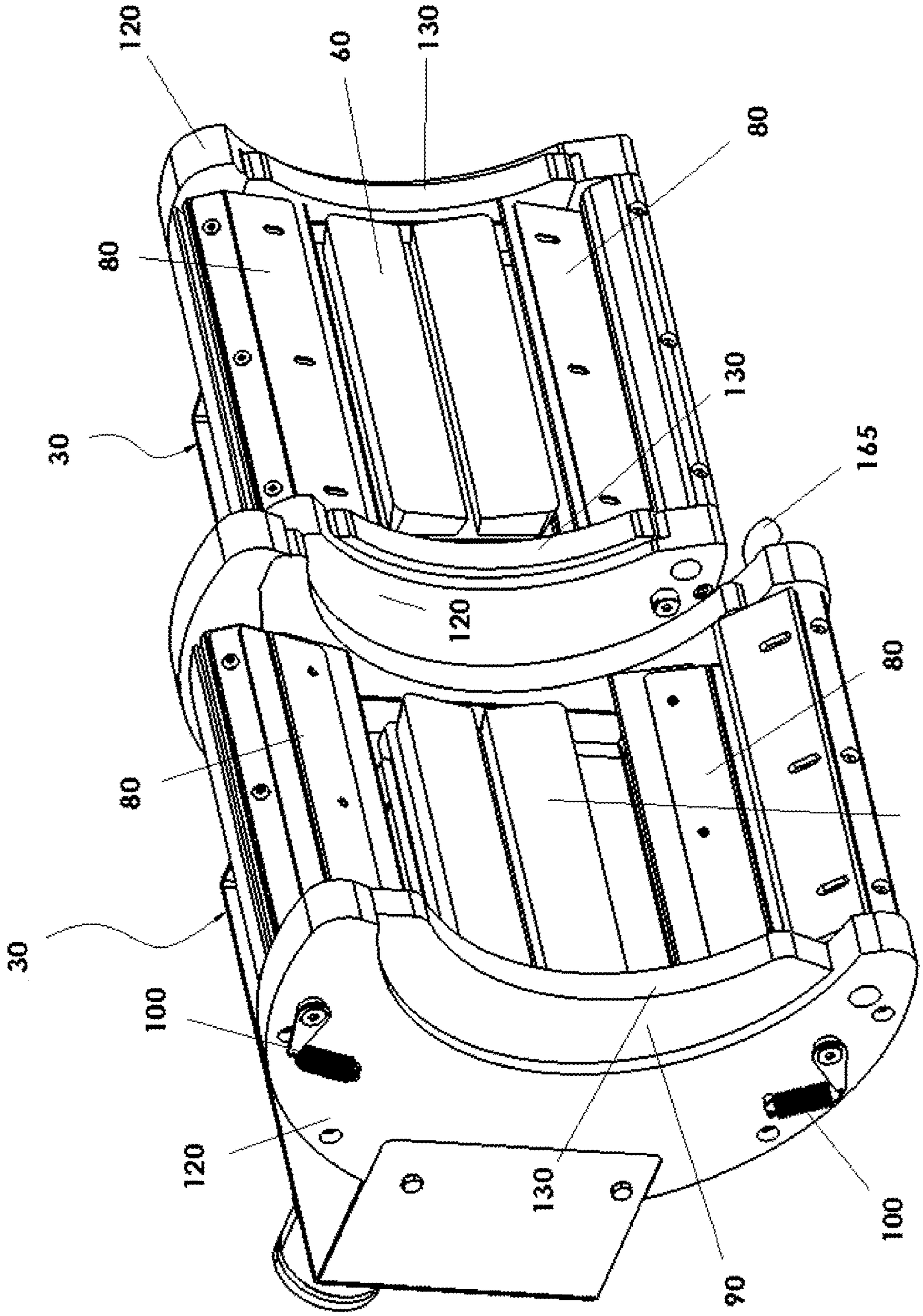


FIG. 6

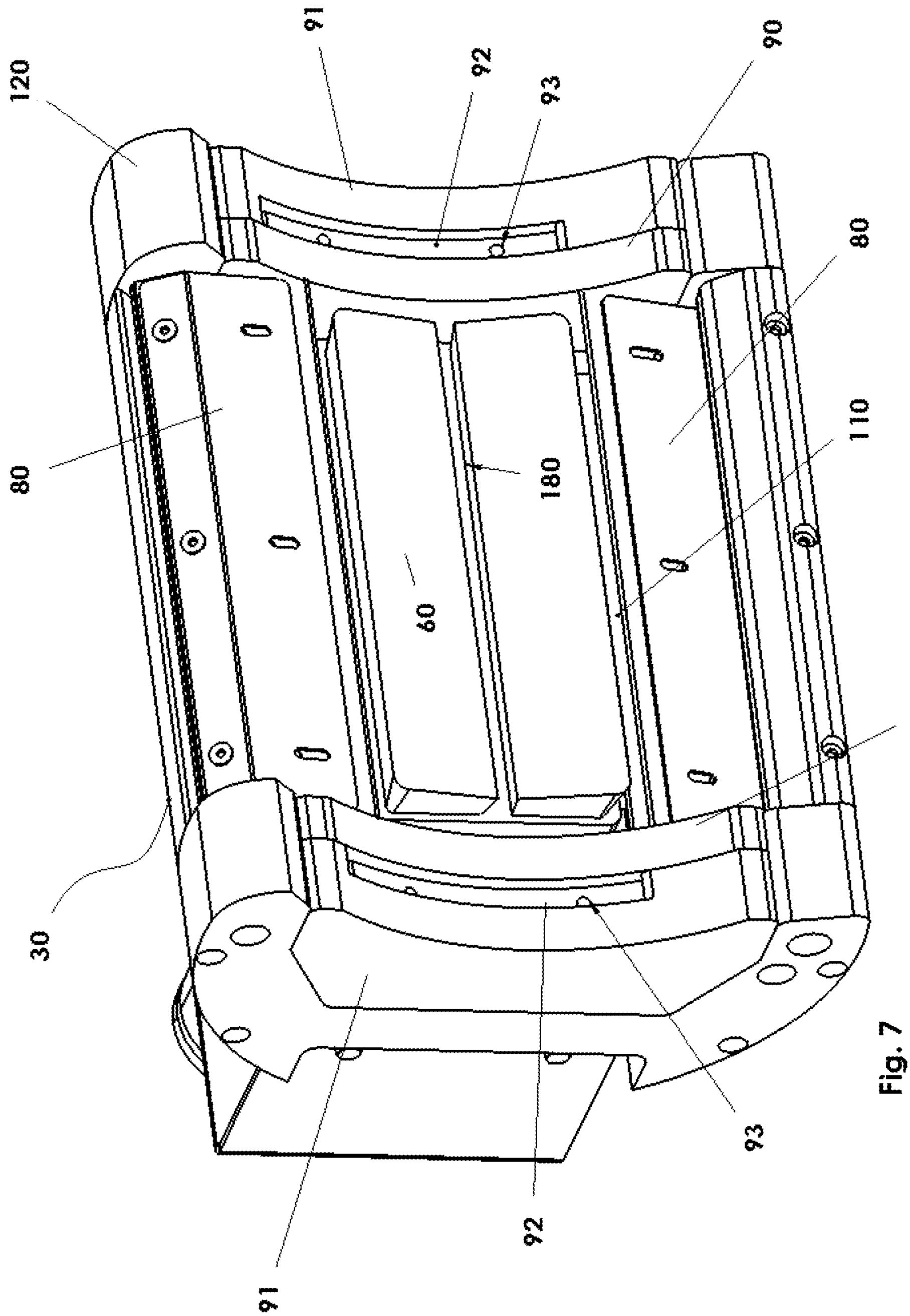
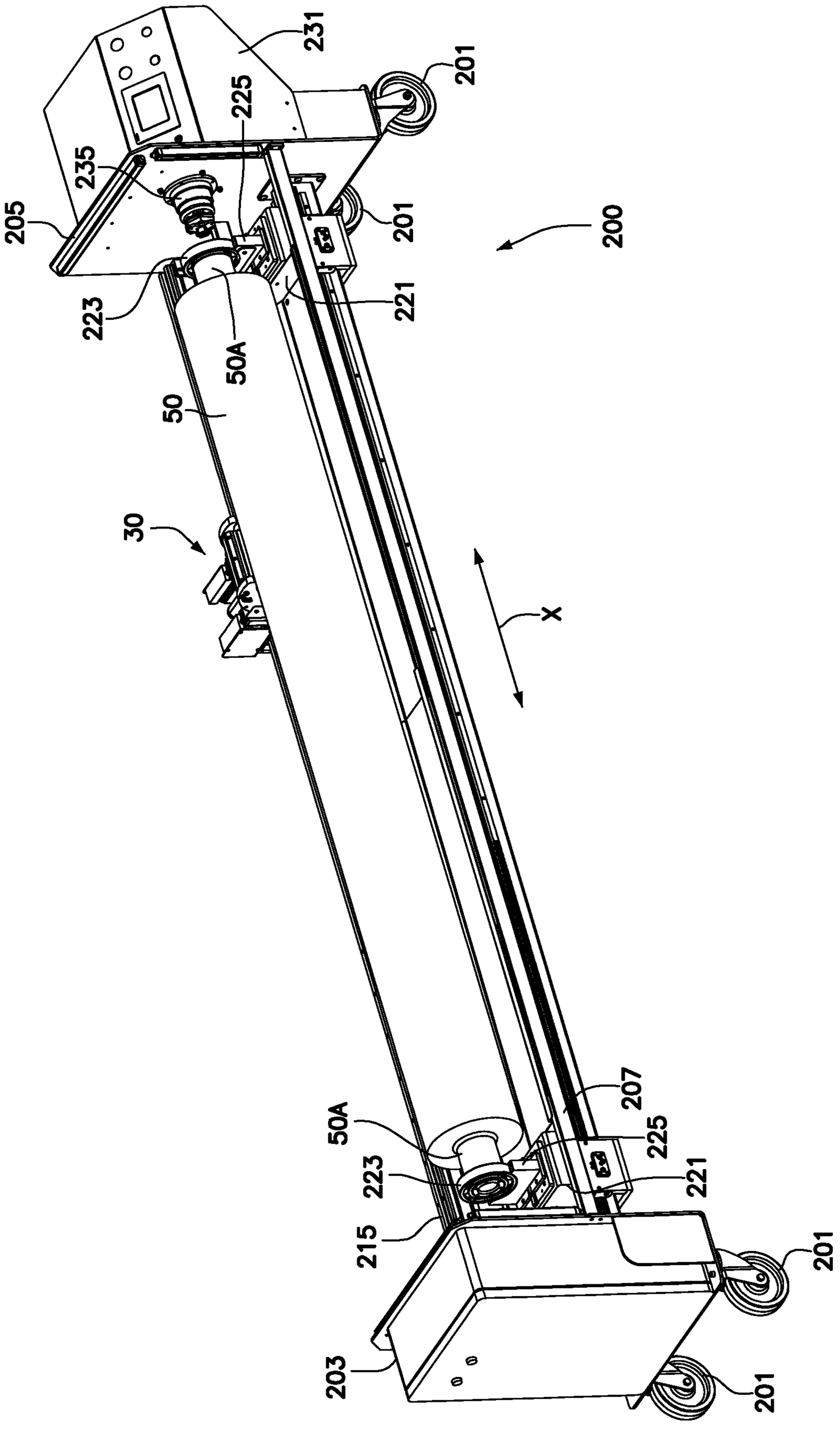


Fig. 7

Fig.8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201
225
235
205
201
200
223
221
50A
50
30
X
207
50A
225
223
221
215
201
203
201

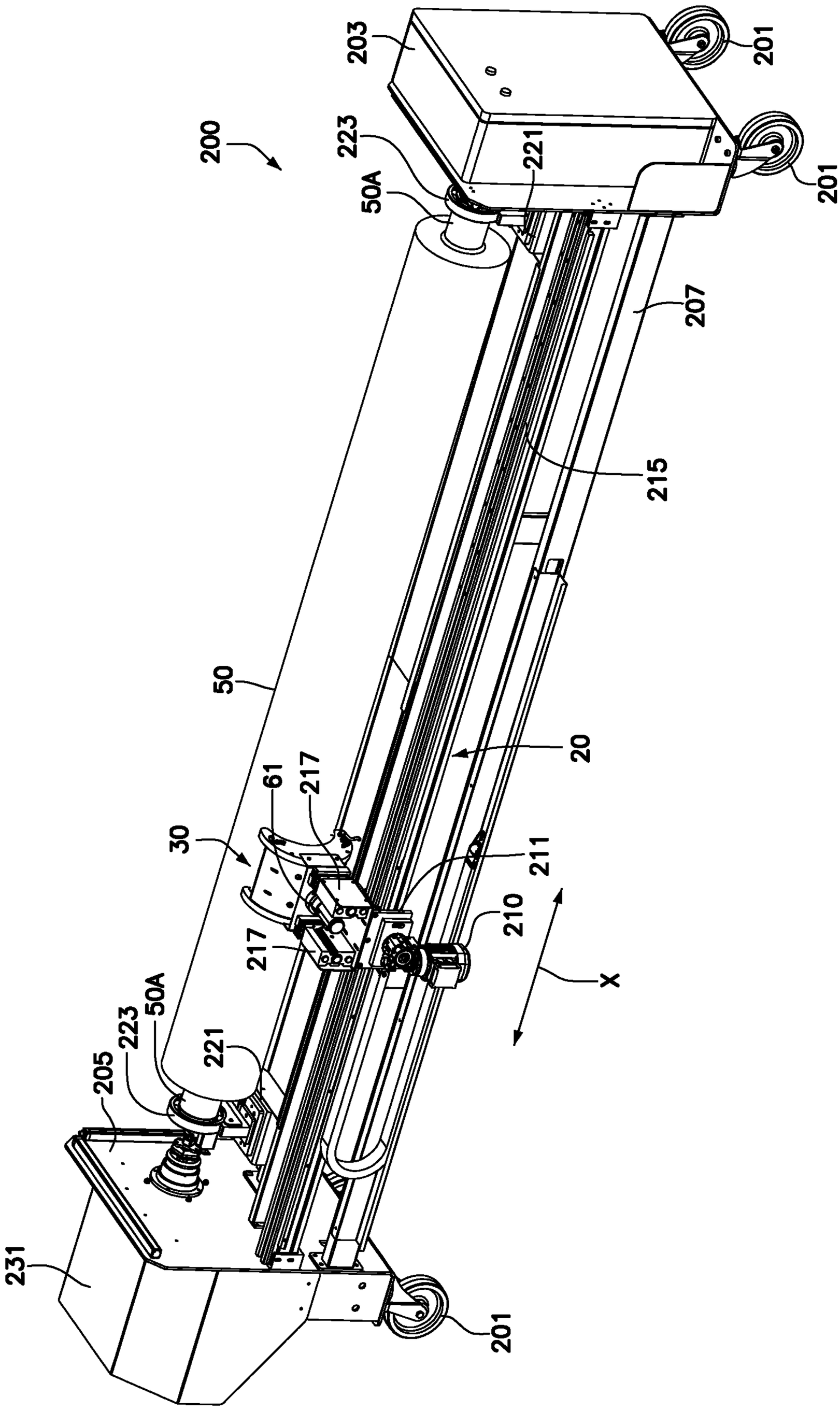
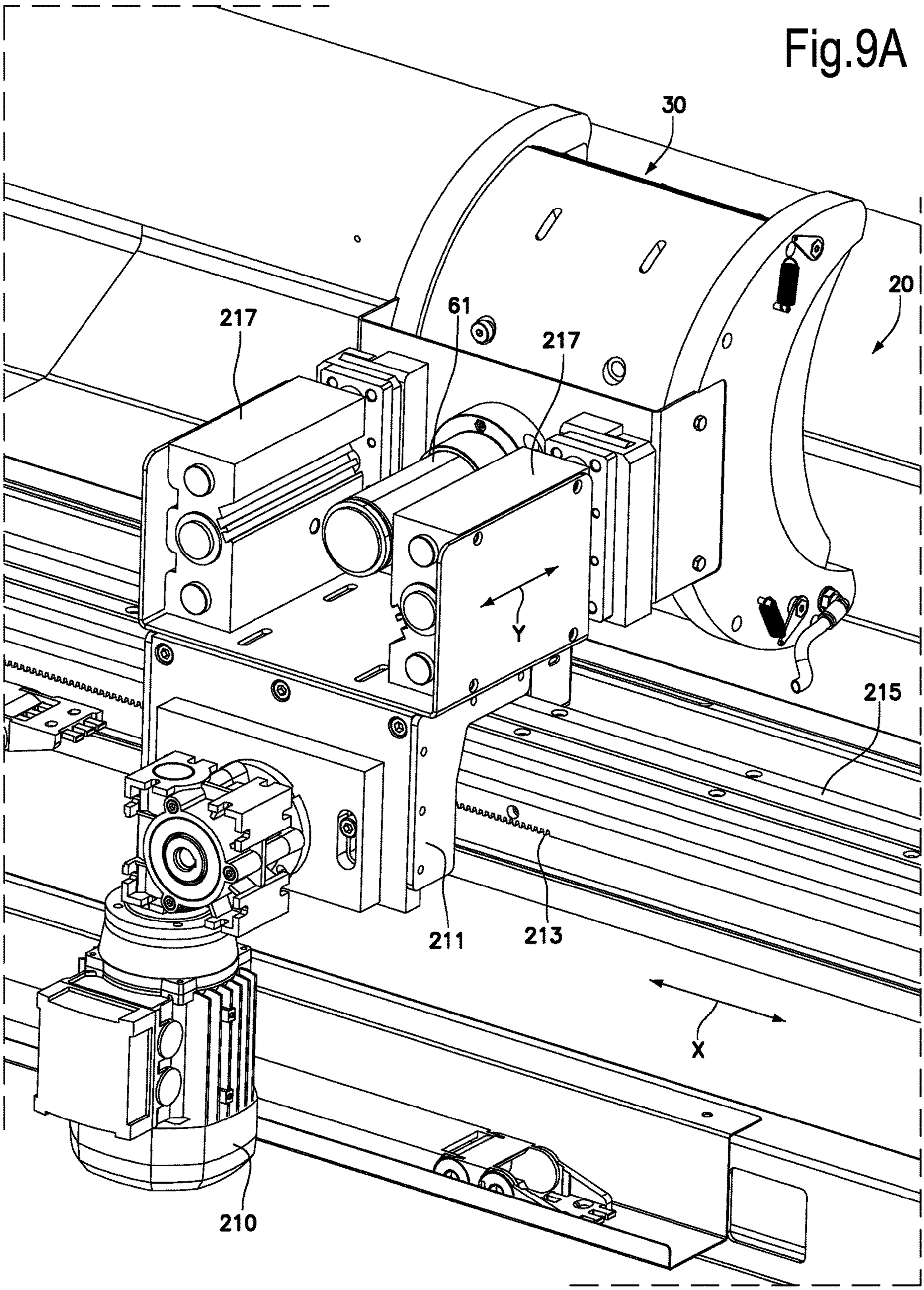

200
203
201
223
221
50A
201
207
215
50
20
61
217
30
211
210
217
X
50A
223
221
205
231
201

Fig.9

Fig.9A



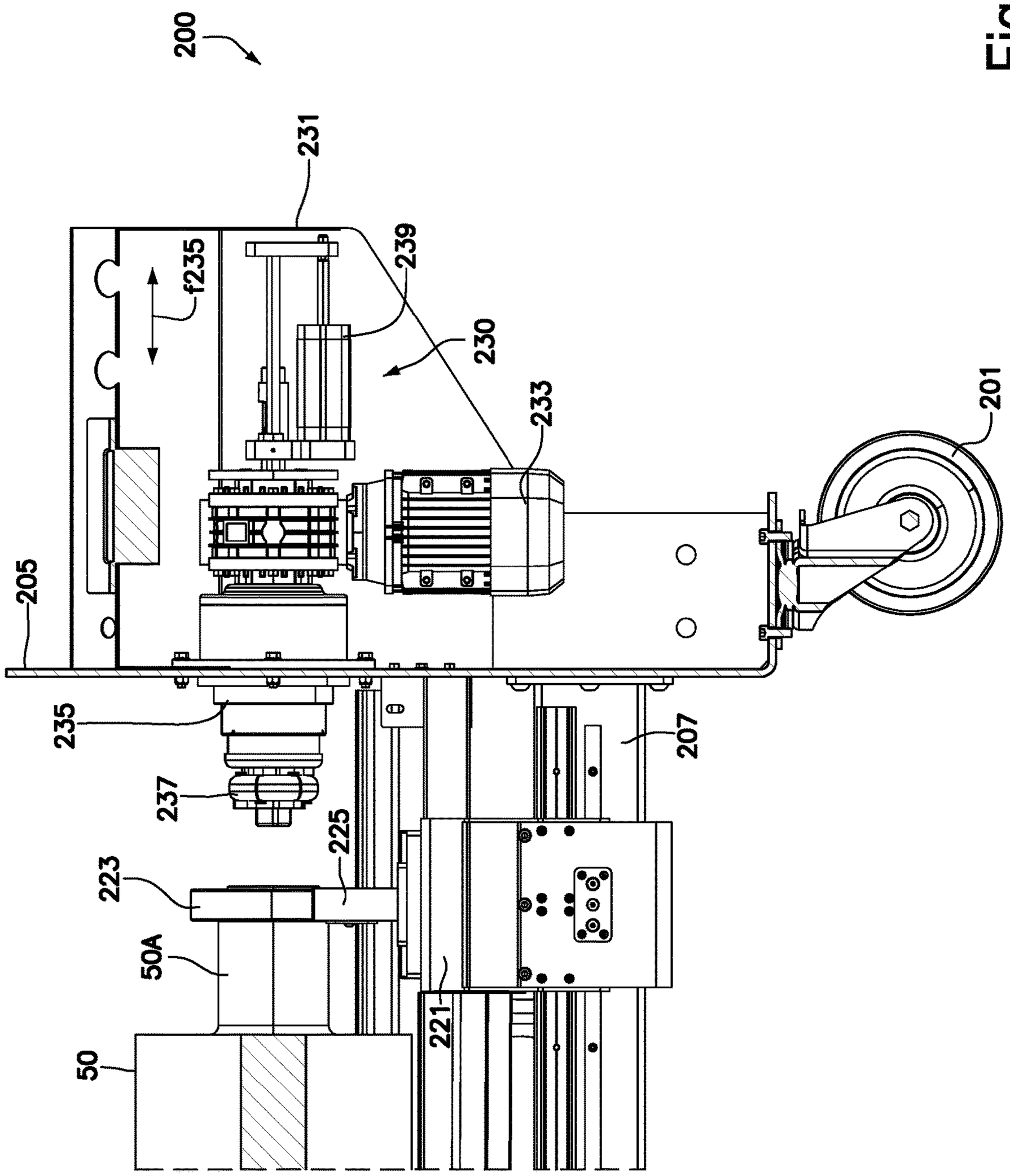


Fig.10

Fig.11

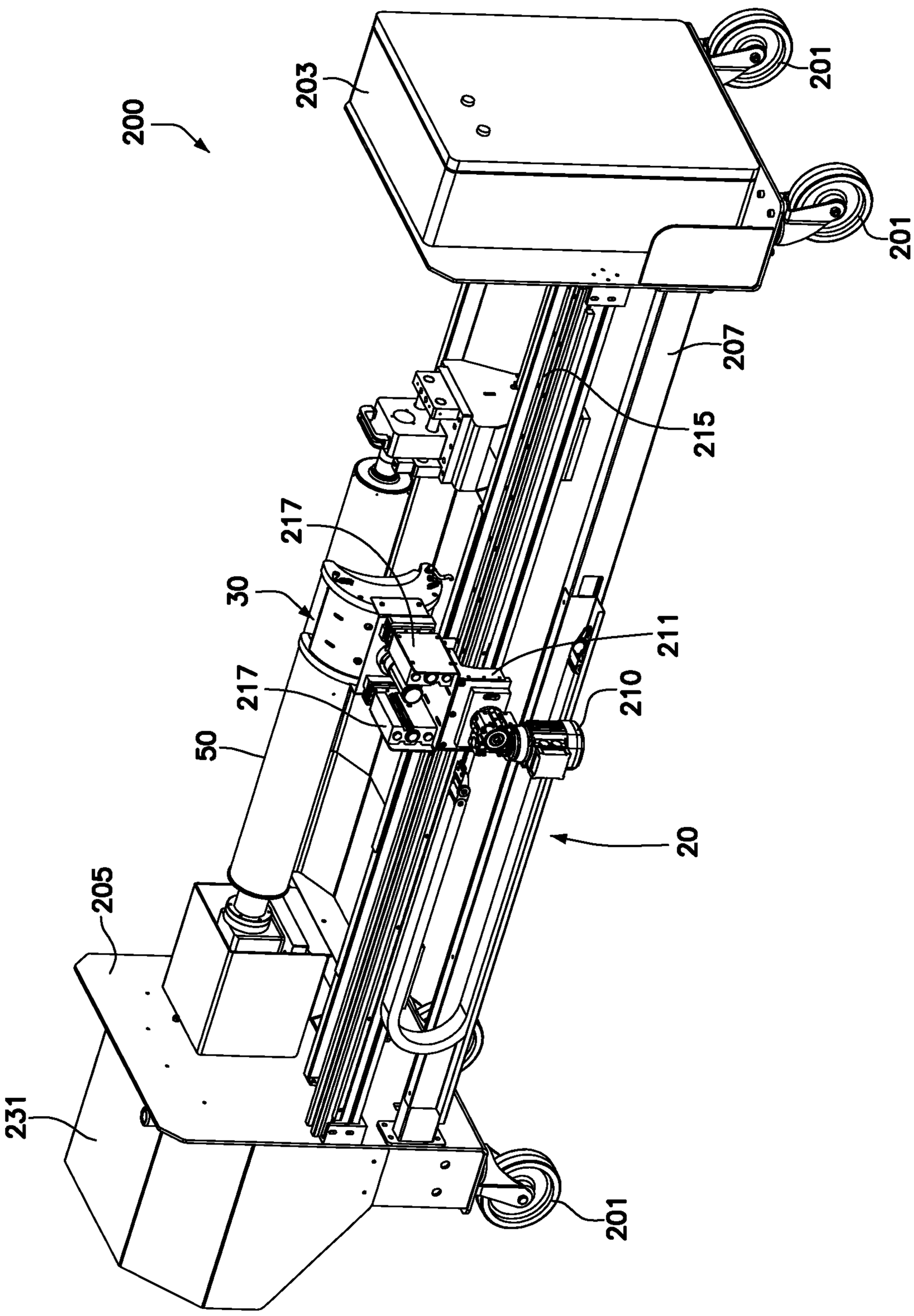
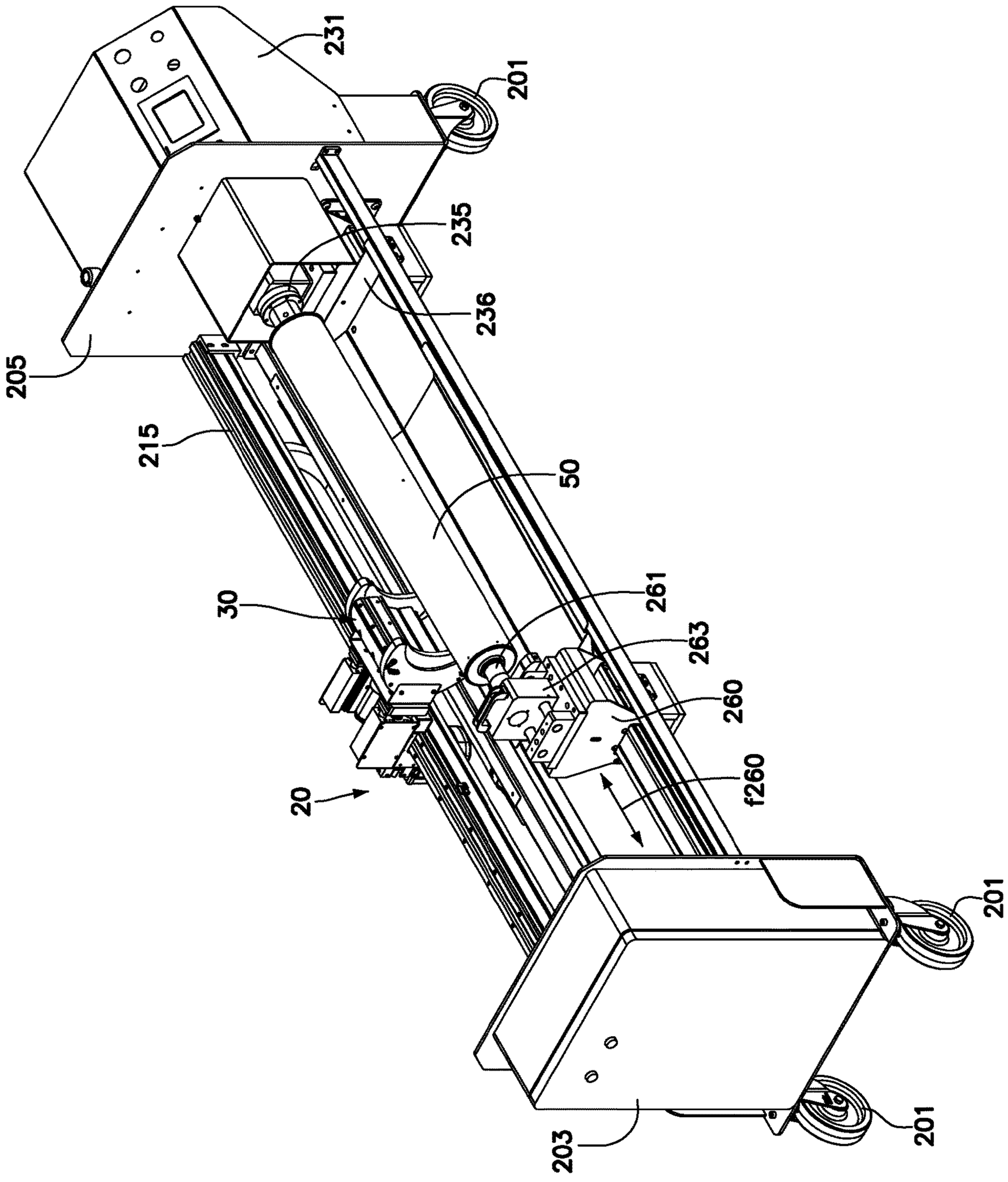


Fig.12



DEVICE FOR CLEANING CYLINDRICAL ROLLERS, MACHINE COMPRISING SAID DEVICE, AND CLEANING METHOD

TECHNICAL FIELD

The present invention relates to a device for cleaning cylindrical rollers, with smooth or engraved surfaces, in particular rollers for printing machines, fluid transfer rollers or the like, such as anilox rollers, cliché rollers, spreader rollers, finishers, laminators or other.

The invention also relates to a method for cleaning a roller.

BACKGROUND ART

Machines for printing web materials, such as, but not limited to, plies of tissue paper, are subject to frequent downtimes to allow cleaning of the rollers, as ply material tends to easily deposit small particles or fibers of material that, being in contact with the printing liquid (ink), soil or fill the small cells that transfer the ink.

These cells, which form the outer surfaces of the transport roller (also called anilox roller), must be kept clean and free from deposits, in order to best perform their function.

In fact, the liquid transferred, also becoming contaminated with debris from the web material to be printed, tends to stratify inside the cells used to transport the liquid, thereby reducing their capacity. This leads to a variation of the technical and/or visual features of the web material, for example due to a decrease in the density of the printing ink.

The frequent halts in the production line required to clean the rollers represent the main reason for loss of efficiency of the line.

Depending on the application field and type of printing machine, the characteristics of the rollers can vary, as can their structure. Therefore, machines have been designed that allow rapid removal of the rollers, in this way allowing them to be washed and cleaned off-line.

In other cases, situations can occur in which the removal of the roller would require very long disassembly, cleaning and reassembly times, for example in the field of rollers for processing corrugated cardboard.

Due to this variability, cleaning systems that operate off-line, i.e., systems in which the roller to be cleaned is disassembled from the production machine, as well as cleaning systems that are installed in-line, i.e., on the production machine, have been developed.

The cleaning systems currently available on the market can be summarized as follows:

manual systems with brushes, which allow the operator to clean the roller by rubbing it with the addition of chemical products. These systems do not guarantee the uniformity of the process and frequently do not comply with the current safety regulations;

Sodium bicarbonate systems, both in-line and off-line versions. These are efficient as regards the process, but very complex as regards management of the machine and of the product (baking soda) used, not always available with the ideal characteristics for the cleaning process;

laser systems applicable in-line or off-line. These systems are very costly and require the use of highly skilled personnel to avoid damaging the roller to be cleaned;

high-pressure water jet machines;

washing systems with dry ice;

washing systems using only chemical products. These can operate in-line and off-line. In the first case, the ink must be

replaced. This system has the drawback that the cleaning liquid comes into contact with all the machine components and, being very aggressive, may damage some of the components. Moreover, the action of the cleaning liquid is not combined with a mechanical action. Therefore, in order to be effective, in addition to the use of an aggressive liquid, the washing operation also requires very long performance times.

In the case of off-line systems, the roller to be cleaned must be removed from the production line and machines used to clean it are very cumbersome.

Prior art cleaning systems are not sufficiently fast and reliable. In fact, known cleaning systems make use of consumables that are wasteful, polluting and have a high environmental impact (also for the operators in the immediate vicinity), or that do not guarantee satisfactory results in reasonable times.

Known cleaning systems, which use jets of cleaning liquid directed at a roller of a printing machine are disclosed in U.S. Pat. Nos. 7,428,868; 6,957,607; WO1997000173.

Therefore, there is the need to produce cleaning devices for cylindrical rollers that completely or partially solve one or more of the problems of the prior art devices.

SUMMARY

The main object of the present invention is to provide a device that is fast, reliable and inexpensive, with regard to the cost of the system and the cost of the consumables.

The object of some embodiments is to obtain a cleaning device that can be easily installed, both in-line (i.e., on the machine) and off-line, in any working environment and without requiring particular safety equipment, as it has a small size, low weight, limited consumption of material and reduced cleaning cycle performance times. This means it can also be installed on existing machines with a quick replacement of existing devices, or added to plants without cleaning devices.

According to a first aspect, there is provided for this purpose a cleaning device comprising a cleaning head with a cleaning chamber, in which a mechanical cleaning member is housed, and with which feeding members are associated for feeding a cleaning liquid into the cleaning chamber. With this layout, the mechanical member and the cleaning liquid dispensed by the feeding members work in combination inside the cleaning chamber to clean the cylindrical surface of the roller to be cleaned.

To clean rollers of considerable axial length with a device of limited dimensions, according to advantageous embodiments the cleaning head is provided with a translation movement in a direction parallel to the axis of the cylindrical roller. The combination of the rotation movement of the roller and the translation movement of the cleaning head allows the whole of the cylindrical surface of a roller, even with considerable radial and/or axial dimensions, to be washed efficiently in a small space.

In advantageous embodiments the cleaning head can be provided with a movement toward and away from the roller. The movement can be in an axial direction, i.e., can be such as to move the head away beyond an axial end of the roller. However, in preferred embodiments, the movement of the cleaning head toward or away from the lateral surface of the roller is orthogonal to the rotation axis of the roller, or in any case a movement that has at least one component orthogonal to the axis of the roller.

To obtain efficient washing, the cleaning head and, together with it, the mechanical cleaning member can be

moved with respect to the lateral surface of the roller to be washed, maintaining the contact between mechanical cleaning member and surfaces of the roller. However, for more efficient washing and to reduce mechanical stresses on the components of the device, advantageously the mechanical cleaning member is provided with a movement inside the cleaning chamber, movement that does not involve the remaining parts of the cleaning head.

In some embodiments, this movement can be a rotation movement. For example, the mechanical cleaning member can comprise a rotating brush, or preferably two counter-rotating brushes.

In currently preferred embodiments, the movement of the mechanical cleaning member is a reciprocating movement, preferably in a direction parallel to the rotation axis of the roller.

To delimit the cleaning chamber, the cleaning head can comprise lateral sealing gaskets. These lateral sealing gaskets can have concave edges, with a curvature corresponding to, or slightly lower than that of the roller to be cleaned, so as to embrace the roller if necessary with a slight elastic deformation of the gaskets, to improve the lateral seal.

The lateral sealing gaskets can be replaceable as a function of the diameter of the roller to be cleaned. For example, the lateral sealing gaskets can be housed in respective side elements that form lateral walls of the cleaning chamber. The side elements can be adapted to house the lateral sealing gaskets of variable dimensions, as a function of the variable diameter of said roller to be cleaned.

For efficient closing of the cleaning chamber, in some embodiments the cleaning head comprises an upper sealing blade and a lower sealing blade, adapted to delimit the cleaning chamber above and below. In advantageous embodiments the blades can be biased against the roller to be cleaned to improve the seal. For this purpose, the blades can be elastic, or can be associated with pressure members, such as piston-cylinder actuators, or springs or other elastic biasing members.

The mechanical cleaning member can comprise at least one brush.

According to a further aspect, the present invention also relates to a machine comprising a cylindrical roller to be cleaned and a device as defined above and as better described below with reference to examples of embodiment.

According to yet another aspect, the invention relates to a method for cleaning a roller, comprising the following steps:

moving, toward a lateral cylindrical surface of the roller, a cleaning head comprising a cleaning chamber open toward the cylindrical surface of the roller and containing therein a mechanical cleaning member and feeding members of a cleaning liquid into the cleaning chamber;

bringing the mechanical cleaning member into contact with the lateral cylindrical surface of the roller to be cleaned, so as to substantially close the cleaning chamber from the front side;

moving the mechanical cleaning member into contact with the lateral surface of the roller dispensing cleaning liquid into the cleaning chamber.

Further aspects and embodiments of the device and of the method according to the present invention are described hereunder with reference to the accompanying drawings and are defined in the appended claims, which form an integral part of the present description.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood with reference to the accompanying figures, which show an application, but without limiting the scope of the present invention. In the accompanying drawings:

FIG. **1** shows an overall view of an embodiment of the device of the present invention, installed on a printing machine;

FIG. **2** shows a partial sectional view of the cleaning head of the device obtained according to II-II of FIG. **3**;

FIG. **3**A shows a front view of the cleaning head of FIG. **2**;

FIG. **3**B shows a lateral view of the cleaning head;

FIG. **3**C shows an axonometric view of the cleaning head;

FIG. **4** shows an axonometric view of the mechanical cleaning member;

FIG. **5** shows a lateral view of the mechanical cleaning member of FIG. **4**;

FIG. **6** shows an axonometric view of two cleaning heads with the same function but with different dimensions,

FIG. **7** shows an axonometric view of a further embodiment of the cleaning head, with lateral rinsing chambers;

FIGS. **8** and **9** are two isometric views of a machine according to a further embodiment;

FIG. **9**A is an enlargement of the cleaning head of FIG. **9**;

FIG. **10** is an isometric view with parts removed of a detail of FIGS. **8** and **9**; and

FIGS. **11** and **12** are two isometric views of a machine according to a yet further embodiment.

DETAILED DESCRIPTION

Hereunder the cleaning device is described in combination with an anilox roller of a printing machine. However, it must be understood that a cleaning device of the type described here can also advantageously be applied to clean other rollers affected by similar problems.

FIG. **1** shows an overall view of a printing machine generically indicated with **10**, for example destined for printing and decorating a ply web material (not shown), which houses a cleaning device **20** of the invention. The cleaning device **20** is essentially composed of two parts, indicated respectively with **30** (cleaning head) and **40** (movement assembly).

The cleaning head **30** acts, in the example illustrated, on an anilox roller **50**, which has on the surface a coating made of a hard material, for example a ceramic material, engraved with small cells, which transport the printing liquid, typically an ink. These cells (not shown) can become at least partially clogged with debris consisting of particles of paper and ink. When this occurs the anilox roller **50** becomes unusable and requires a cleaning operation. For this purpose, the cleaning head **30** is brought into close proximity of the anilox roller **50** and subsequently made to translate in a direction parallel to the axis of the roller **50**, as better described below.

With reference to FIGS. **3**A, **3**B, **3**C, the cleaning head **30** comprises various components, including a mechanical cleaning tool **60**, which can be a brush or the like. The cleaning head further comprises a pair of nozzles **70** for spraying a cleaning liquid, upper and lower sealing blades **80** and lateral sealing gaskets **90**. When the cleaning head **30** is in the operating position and coacts with the anilox roller **50**, the assembly made up of the upper and lower blades **80** and of the sealing gaskets **90** forms, together with the cylindrical surface of the roller **50**, a fluid tight cleaning chamber **110**.

In advantageous embodiments, the blades **80** are adjustable and held with pressure against the roller **50** to be cleaned through the use of compression members **100**

(FIGS. **3**B, **3**C) exemplified here in the form of springs, which allow fluid tightness in the upper and lower part of the cleaning chamber **110** also when the there is a variation in the diameter of the roller **50** to be cleaned, as the blades **80** are always in contact and with a certain pressure against the roller **50**.

The sealing gaskets **90** are supported by respective side elements **120** that, in the same way as the blades **80**, can accommodate gaskets **90** of different dimensions, or rather with a concave profile **130** adapted to the variable diameter of the roller **50**. This means that, with the same cleaning head **30** and the same side elements **120** it is possible to clean rollers **50** with various diameters, as the cleaning chamber **110** will in any case remain exempt from seepages or leakages of liquid, due to the spring adaptability of the blades **80** and to simple replacement of the sealing gaskets **90**.

More specifically the blades **80** can be substantially rigid and can adapt to the dimension of the roller **50** by pivoting around a hinge axis under the action of the approaching roller **50** and under the action of a spring, such that the free edge of the blades **80** can be urged elastically, e.g. by springs **100**, against the outer cylindrical surface of the roller **50**. Also the gaskets **90** can be substantially rigid. The profile **130** of the gaskets **90** is shaped to match the outer cylindrical surface of the roller. As used herein the term "substantially rigid" means that it does not deform under the load applied by the roller during the cleaning operation.

The above described arrangement allows efficient cleaning and flexible adaptation to rollers of variable diameter.

As the variation of the diameter of the rollers **50** to be cleaned ranges from around 150 mm to around 300 mm, in some embodiments the side elements **120**, and with these elements the whole cleaning head **30**, can cover roughly half of the range indicated above. This means that it will be possible, for example, to have a first cleaning head **30**, and respective side elements **120**, to install on the cleaning device **20** for rollers **50** of diameter comprised between around 150 mm and around 220 mm, and a second different (larger) cleaning head **30** with side elements **120** of a size which is larger than previous ones, for rollers **50** with a diameter comprised between around 220 mm and around 300 mm. FIG. **6** shows, in an axonometric view, compared with each other, two cleaning heads **30** of different dimensions to cover the whole range of diameters of the roller **50** to be cleaned.

In this way with two different cleaning heads **30**, with dimensions different from one another, it will be possible to perform cleaning of rollers **50** with any diameter comprised between around 150 mm and around 300 mm. In fact, it will be sufficient to install on the cleaning device **20** the head **30** with larger or smaller side elements **120** depending upon the diameter of the roller **50** to be cleaned.

In the case of a small variation in the diameter of the roller **50** it will not be necessary to change the side elements **120**, but it will be sufficient to replace the sealing gaskets **90** corresponding to the new diameter of the roller **50** to be cleaned.

As mentioned above, a mechanical cleaning member, in this case a brush **60**, is arranged inside the cleaning chamber **110**. Advantageously, the brush **60** is translated with a reciprocating movement in a direction parallel to the axis of the roller **50**. In this way, the combined action of the liquid injected at low pressure by the nozzles **70** and the reciprocating movement of the brush **60** allows fast, efficient and low cost cleaning of the cylindrical surface of the roller **50**. In the illustrated example, the movement of the brush or other mechanical cleaning member **60** is obtained with an actuator, for example a pneumatic motor **61**, and the motion is transmitted, for example, through a cam and eccentric or the like, indicated schematically with **62**, although it would also be possible to use other systems known in the art.

In some embodiments, the brush **60** is advantageously formed of two parts **140** (FIG. **4**) extending in transverse direction (parallel to the axis of the roller **50**), so as to leave a channel **180** between the two parts **140**. In this way, a small amount of cleaning liquid coming from the nozzles **70** is maintained in direct contact both with the roller **50** and with the bristles forming the two parts **140**.

The two parts **140** of the brush **60** advantageously have a dovetail shape (see in particular FIGS. **2** and **5**), so as to bring the bristles of the two parts **140** as close as possible to the roller **50** to be cleaned, and to create an obligatory path for the cleaning liquid (maximizing the contact time of the cleaning liquid on the roller and consequently its removal efficiency).

More in particular, as shown in FIG. **5**, each of the two parts **140** of the brush **60** has a surface (for example formed by the tips of the bristles that make up each part **140** of the brush **60**) that form an angle α with a vertical plane. The angle α can for example be from around 5° to around 20°, preferably from around 10° to around 15°, preferably of around 12°. The aforesaid inclined surfaces of the parts **140** of the brush **60** are inclined in opposite directions, so as to be arranged, in substance, on the two sides of a "V" with opening (**180**-**2***a*) degrees, so that the two parts **140** of the brush **60** embrace the cylindrical surface of the roller **50** as much as possible.

The brush **60** can be provided with bristles of different thickness and material, for example the bristles can have dimensions comprised between 0.05 and 0.5 mm, advantageously between 0.1 and 0.2 mm and be made of filaments of brass, steel, plastic or animal material, or the like. The aforesaid parameters and materials can vary as a function of the shape and of the material of the surfaces to be cleaned, and of the pressure required and expected useful life of the bristles. It would also be possible to use brushes **60** provided with mixed bristles, i.e. made of different materials, for example harder and softer bristles, which can have various arrangements. For example, clumps or groups of bristles of a first type can be arranged alternated with clumps or groups of bristles of a second type.

To be able to adapt to rollers **50** to be cleaned with different diameters, the brush **60** can be supported so that it also slides in a direction (indicated with Z in FIG. **2**) toward the roller **50** to be cleaned. This forward movement according to the direction Z has the dual purpose of offsetting any differences in the diameter of the roller **50** to be cleaned, and of adjusting the pressure exerted by the bristles **140** on the roller **50**. This latter characteristic can also be exploited to offset partial wear of the bristles, so that the effectiveness of the action of the brush **60** remains more or less constant, extending the useful life of the brush **60**. The number **71** (FIG. **2**) indicates a fixing and adjustment column, along which the cleaning head **30** can translate to move toward the axis of the roller **50**.

For the same reason, the cleaning head **30** can be supported by an arm (not shown) adjustable in length, so that the seal of the blades **80** and of the sealing gaskets **90** is guaranteed against seepage of cleaning liquid and of any residues removed from the roller **50**.

As mentioned initially, the cleaning head **30** (see. FIG. **1**) is mounted on a movement assembly **40** that controls translation of the cleaning head **30** in a direction parallel to

the axis of the roller **50**. The movement is indicated by the double arrow X in FIG. **1** and is advantageously a two-way movement, so that the cleaning head **30** can translate in the two directions to act on the whole cylindrical surface of the roller **50**. The translation movement can be imparted to the head **30** by any known movement system. In the case shown, a rack and pinion system is used, but it would be possible to use other known systems, for example with belt and pulley, with gears, with recirculating ball screws or the like.

In some embodiments, one or more holes **160** (FIG. **2**) are arranged in the lower part of the cleaning chamber **110**, connected to which are pipes **165** (FIG. **3**A) for collecting and recovering the cleaning liquid and any debris detached from the roller **50**. Evacuation of the remaining cleaning liquid and of any debris can take place through gravity or vacuum, both induced from the outside, or through slight overpressure that is created in the cleaning chamber **110**.

The lateral sealing gaskets **90** can be housed in respective seats, obtained in negative in the side elements **120**, so that the gaskets **90** with concavity **130** with different diameters (to operate on rollers **50** with different diameters), can in any case be installed on the same side elements **120**. This makes the cleaning head **30**, and hence the whole cleaning device, extremely versatile. Moreover, the shape of the gaskets **90** is such that they are very easy to replace without the aid of particular tools.

In fact, as described above, simply by replacing the sealing gaskets **90**, it is possible to obtain effective cleaning of rollers **50** with very variable diameters, for example in a range comprised between around 150 and around 220 mm, or between around 220 and around 300 mm. Advantageously, also the blades **80** contribute to this flexibility of the device, as for the aforesaid range of diameters of the roller **50** to be cleaned, the simple action of the springs **100** (FIG. **3**A) is sufficient to guarantee the seal in the direction of rotation of the roller **50**, both in the upper part and in the lower part of the cleaning chamber **110**.

The lateral sealing gaskets **90** can be made of different materials, provided the material has sufficient resistance to sliding friction and does not overheat. A particularly suitable material has proven to be "EVA" closed cell expanded polyethylene, with a density comprised between 50 and 120 kg/m^3. However, it would also be possible to use other materials with similar or improved characteristics with respect thereto.

The device described above functions as follows.

The cleaning head **30** of the device **20** is brought into close proximity of the roller **50** to be cleaned. A slight forward movement of the head **30** in the direction of the roller **50** causes closing of the cleaning chamber **110**, delimited laterally by the sealing gaskets **90**, which can have the concave front part **130** with a radius of curvature equal to or slightly smaller than the radius of the roller **50**. The sealing gaskets **90** can be moved toward the roller **50** with a slight pressure against the cylindrical lateral surface of said roller **50**. The cleaning chamber **110** is delimited on top and on the bottom by the blades **80** held with pressure against the roller **50** by the springs **100** or another suitable member, for example another elastic member, a piston-cylinder actuator or other suitable means. Thanks to the particular structure of the blades **80** and of the gaskets **90** that the cleaning chamber **110** remains sealingly closed regardless of the direction of rotation of the roller **50**. The cylindrical surface of the roller **50** completes the front closing of the cleaning chamber **110**, while a wall **31** (FIG. **2**) of the cleaning head **30** closes it at the rear.

After the forward movement and sealing of the cleaning chamber **110**, the brush **60**, with its bristles **140** coming into contact with the surfaces of the roller **50** to be cleaned through the forward movement of the head **30** toward the roller **50**, starts to move inside the cleaning chamber **110** in a direction transverse to the roller, i.e., parallel to the axis thereof, so as to cause the bristles of the brush **60** or other mechanical cleaning member to rub against the surfaces of the roller **50** to be cleaned.

Simultaneously, the nozzles **70** inject cleaning liquid, which can consist of water, a solution of water and detergent, or another liquid product with a cleansing action. The combined action of rubbing of the bristles of the brush **60** and of the cleaning liquid, ensure that the portion of surfaces of the roller **50** to be cleaned involved and circumscribed by the cleaning chamber **110** is easily cleaned. The particles of paper, ink, or any other processing residues that have deposited in the cells of the roller **50** are easily removed. The used cleaning liquid flows downward, thus drawing the debris toward the hole or holes **160**, from where it is removed through the pipe or pipes **165**. The supply and removal of the cleaning liquid can take place discontinuously or preferably continuously.

In particular cases, for example in case of particularly stubborn dirt, it is possible to use a heated cleaning liquid, so that it is even more effective on the dirt to be removed. The cleaning liquid can be water or any cleaning product, pure or diluted, and can be heated, for example, to a temperature comprised between 25° C. and 50° C., preferably between 30° C. and 45° C.

To perform cleaning of the whole cylindrical surface of the roller **50** it is sufficient to rotate the roller **50** to cover the entire circumference thereof. Through a simple translation of the cleaning head **30** in the direction X (FIG. **1**), parallel to the axis of the roller **50**, it is possible to gradually clean the various annular portions of the roller from one end to the other. By providing an operation with continuous movements, i.e. with continuous rotation of the roller **50** and continuous translation of the cleaning head **30**, fast and efficient cleaning can be obtained with a simple device, which requires a small operating space around the roller **50** to be cleaned.

According to further embodiments, the cleaning head **30** can be provided with means to prevent or limit the lateral seepage of cleaning liquid during use. For example, FIG. **7** shows a configuration of cleaning head **30** with double containment chamber. The same numbers indicate the same or equivalent parts to those already described with reference to the preceding figures, which will not be described again. The main difference between the cleaning head **30** of FIG. **7** and those illustrated in the preceding figures substantially consists in that a further lateral sealing gasket **91**, adjacent to the respective sealing gasket **90** described above, is added laterally on the left and right sides of the cleaning head **30**.

An empty chamber **92** is formed between the two lateral gaskets **90**, **91** of each side of the cleaning head **30**. Nozzles **93** for feeding a rinsing liquid, for example water, flow into said chamber **92**.

With this configuration of the cleaning head **30** it is possible to manage both the cleaning step of the roller **50** by means of liquid detergents, and the subsequent rinsing step.

It would also be possible to add, if necessary, in a further lateral chamber for each side, a suction system of the cleaning liquid and/or of the rinsing liquid.

Summarizing, the advantages that can be obtained with embodiments of the device according to the present invention are:

the cleaning process can combine the action of any chemical detergent with the action of a mechanical member;

with the same process effectiveness, the system is less expensive than existing systems;

it is possible to process any engraving profile and up to very high line counts (600 lines/cm);

there are no dispersions of cleaning product;

the amount of cleaning product used is very small;

with the same process effectiveness, the system is faster than existing systems;

it can be used in any working environment without the operator requiring particular protective and/or safety equipment;

it is very simple to use and the operator does not require to have any particular training.

While in FIG. **1** the cleaning device **20** is arranged on a printing machine, in other embodiments the cleaning device **20** can be arranged on a cleaning machine, i.e. on a machine the purpose whereof is just to clean rollers, for instance intended to be used for cleaning rollers from one or more different printing machines or the like. It would thus be possible, for instance, to provide a single cleaning machine serving a plurality of printing machines at the same time. A single cleaning unit or device **20** would then be exploited more efficiently to clean a larger number of rollers from several printing lines.

An embodiment of a cleaning machine **200** including a cleaning device **20** as described above is illustrated in FIGS. **8**, **9** and **11**. The cleaning machine **200** can be adapted to clean a roller **50**, for instance a roller of a printing machine. The roller **50** can be an anilox roller, or a cliché roller or the like.

The cleaning machine **200** comprises a supporting structure, adapted to support a cleaning device **20** including a cleaning head **30**. The cleaning machine **200** further includes supporting devices for rotatingly supporting a roller to be cleaned as well as a driving unit to drive the roller into rotation around the axis thereof during cleaning. The cleaning head **30** can be configured as described above in connection with FIGS. **1** to **7**. The structure of the cleaning head **30** will therefore not be described again.

The cleaning machine **200** can be movable, for instance by means of wheels **201**. In the exemplary embodiment of FIGS. **8** to **10** the cleaning machine **200** includes four pivoting wheels **201**. The cleaning machine **200** can be adapted to be moved manually or by means of a mover, such as a self-propelled vehicle. In other embodiments, the cleaning machine **200** may be equipped with its own motor, such as an electric motor.

The cleaning machine **200** further includes two end units **203**, **205** connected to one another, e.g. by beams **207**.

In some embodiments the cleaning head **30** is movable between the two end units **203**, **205** in a direction parallel to beams **207** according to double arrow X.

Reciprocating movement of the cleaning head **30** according to arrow X can be controlled by an electric motor **210**. The cleaning head **30** can be positioned on a slide **211**, which also carries the electric motor **210**. The driving shaft of the electric motor **210** can be provided with a pinion meshing with a rack **213**, which extends parallel to the beams **207** and to a guide **215** along which the slide **211** moves under the control of electric motor **210**. Instead of an electric motor, a pneumatic motor, a hydraulic motor or any other suitable driver can be used. Also, a linear motor, such as a linear electric motor can be used instead of a rotating motor **210** and relevant rack-and-pinion transmission. Other mechanical transmissions can be provided, instead of a rack-and-pinion transmission, for instance a threaded bar meshing with a nut.

The cleaning head **30** is movable with respect to the slide **211** in a direction orthogonal to arrow X, in order to approach a roller **50** and move away therefrom. This movement is pictorially represented by double arrow Y (FIG. **9**A). The movement according to double arrow Y can be controlled by one or more actuators. In the embodiment of FIGS. **8**, **9** and **10** two cylinder-piston actuators **217** are provided to control the movement according to double arrow Y. Between the two actuators **217** an actuator **61** (for instance a pneumatic motor) can be positioned, which is adapted to control the movement of the cleaning member **60**. This latter can be configured and operated as described above in relation to FIGS. **1** to **7**.

On the beams **207** two supporting carriages **221** can be arranged, which are adapted to support the roller **50**. At least one or both carriages **221** can be movable parallel to the beams **207** to adjust the distance therebetween according to the axial length of the roller **50**. In some embodiments, one or both carriages **221** can be provided with actuators to adjust their position, for example electric motors and relevant transmission means, such as a rack-and-pinion arrangement, or else a threaded bar and nut arrangement or the like.

In some embodiments the roller **50** can be provided with journals **50**A. Each journal **50**A can in turn have a respective bearing **223** mounted thereon. The bearings **223** are intended to rotatingly support the roller **50** in the printing machine where the roller **50** is used and are removed along with the roller **50** when this latter shall be cleaned. The same bearings **223** are thus used to support the roller **50** during cleaning. Each carriage **221** can be provided with a respective cradle **225** (see FIG. **10**), on which the respective bearing **223** rests when the roller **50** is positioned in the cleaning machine **200**.

In some embodiments the cradles **225** can be interchangeable, to adapt to journals **50**A of variable diameter. Moreover, the mutual distance between the supporting carriages **221** can be adjusted to the axial length of the roller **50** to be cleaned, as mentioned above.

In some embodiments, the cleaning machine **200** includes a driving unit **230** to drive the roller **50** into rotation around the axis thereof, while the roller **50** is supported via bearings **223** on the cradles **225**. In the embodiment of FIGS. **8** to **10** the driving unit is associated with the end unit **205**. An embodiment of the driving unit is shown in detail in FIG. **10**. In this embodiment, the driving unit **230** is housed in a housing **231**. The driving unit **230** can include a rotary motor, for instance an electric motor **233**, which controls rotation of a spindle **235**. This latter is collinear with the roller **50** to be cleaned when the roller is placed on the cradles **225**.

The spindle **235** is provided with a roller engaging member **237**. In some embodiments the roller engaging member **237** comprises a magnetic device, for instance including an electromagnet. The electromagnet can be energized when coupling of the spindle **235** to the roller **50** is required.

The spindle **235** is further provided with an approaching and withdrawal movement parallel to the spindle axis, i.e. parallel to the rotation axis of the roller **50** to be cleaned. The approaching and withdrawal movement is pictorially represented by double arrow f**235**. The movement according to double arrow f**235** can be controlled by an actuator, such as a linear actuator, for instance a cylinder-piston **239**.

Operation of the cleaning machine **200** is as follows. The carriages **221** are adjusted in the correct position according to the axial length of the roller **50**. Thereafter, the roller **50** to be cleaned is placed with the bearings **223** thereof on the cradles **225**. The cleaning head **30** of the cleaning device **20** is moved close to the roller **50** by means of actuators **217** and the spindle **235** is axially moved against the roller journal **50**A facing the spindle. The engaging member **237** forming the spindle head is energized such that the spindle **235** becomes drivingly coupled to the roller **50**.

The roller **50** is put into rotation around the rotation axis thereof and the cleaning head **30** is activated to clean the roller **50** as described in connection with FIGS. **1** to **7**.

When the roller **50** has been cleaned, the reverse operations are performed.

The roller **50** can placed on the cleaning machine **200** and removed therefrom with any suitable means, such as a crane, an overhead crane, a fork carriage or the like. The cleaning machine **200** can be moved close to the printing machine wherefrom the roller **50** to be cleaned is removed and/or where the cleaned roller **50** shall be mounted.

FIGS. **11** and **12** illustrate isometric views of another embodiment of the cleaning machine **200**, which is particularly adapted to clean rollers in the form of cylindrical sleeves. Such cylindrical sleeves are often used in printing machines for easy replacement. Rather than replacing a monolithic solid roller, the roller is shaped as a hollow sleeve and is mounted on an inner core. Locking members, such as mechanical, hydraulic or pneumatic locking members (known per se) are used to axially and torsionally lock the sleeve on the core.

The same reference numbers designate the same or equivalent parts as those described above. The cleaning head **30** can be configured as described in connection with FIGS. **1** to **7**. The cleaning device **20** including the cleaning head **30** can be configured as described in connection with FIGS. **8-10**.

The main difference between the cleaning machine **200** of FIGS. **8-10** and the cleaning machine **200** of FIGS. **11**, **12** concerns the manner in which the roller to be cleaned is mounted on the cleaning machine **200**. The difference takes into account the fact that the roller **50** in this embodiment is in the form of a cylindrical hollow sleeve, which is not provided with roller journals and relevant bearings. Different roller supporting devices are thus provided in this case.

In the embodiment of FIGS. **11** and **12** the roller or sleeve **50** is drivingly coupled at one end to the spindle **235**. The opposite end of the roller or sleeve **50** can be engaged by an opposite shaft **261**, which can be idly supported on a slide **263**, in turn mounted on a carriage **260**. The carriage **260** can be movable according to double arrow f**260**, to adjust the distance between the carriage **260** and the spindle **230**. The movement of the slide **263** with respect to the carriage **260** can be in the same direction represented by double arrow f**260** and can be used to lock and unlock the shaft **261** with respect to the sleeve **50**. This makes locking and unlocking faster and independent of the position of the carriage **260** with respect to the supporting beams **207**.

The operation of the cleaning machine **200** of FIGS. **11** and **12** is substantially the same as described above in respect of the cleaning machine **200** of FIGS. **8-10**.

Several modifications and changes can be implemented on the cleaning machine **200** of FIGS. **8** to **12**. For instance, the spindle **235** in FIGS. **11** and **12** can be arranged on a slide **236**, rather than being housed inside the housing **231**. The slide **236** may support a motor, for instance an electric, hydraulic or pneumatic motor (not shown) adapted to drive into rotation the spindle **235**. The carriage **236** can be stationary or movable along beams **207**.

The spindle **235** in FIGS. **11**, **12** can be equipped with a magnetic coupling feature, to co-act with the sleeve or roller **50**.

In other embodiments, the spindle **235** can be drivingly coupled to the roller **50** or to a sleeve **50** with different means, for instance mechanical means rather than magnetic means. A magnetic coupling may be beneficial in terms of easy operation and flexibility, since it can be used for rollers of variable shapes. Locking and unlocking does not require actuation of mechanical means, Actuation is faster and reduces wearing of the mechanical components.

The cleaning head **30** can be easily replaced with a different cleaning head, for instance a dry-cleaning head.

The invention claimed is:

1. A cleaning device for cleaning a cylindrical roller having a longitudinal roller axis and a cylindrical side surface, the cleaning device comprising:

a cleaning head with a cleaning chamber;

sealing blades extending parallel to the roller axis and lateral sealing gaskets extending transversely to the roller axis, the sealing blades and the lateral sealing gaskets closing the cleaning chamber, the lateral sealing gaskets having concave edges configured to sealingly contact the cylindrical side surface of the roller;

a mechanical cleaning member housed in the cleaning chamber;

a first actuator configured to move the mechanical cleaning member inside the cleaning chamber;

cleaning liquid feeding members configured to feed a cleaning liquid into the cleaning chamber; wherein the mechanical cleaning member and the cleaning liquid fed by said feeding members work in combination inside said cleaning chamber; wherein the cleaning head is provided with a translation movement in a direction parallel to the roller axis of the cylindrical roller; wherein the first actuator is configured to move the mechanical cleaning member with respect to the cleaning chamber while maintaining the mechanical cleaning member in contact with the cylindrical side surface of the roller.

2. Device according to claim **1**, further comprising a second actuator configured to move the cleaning head toward and away from the roller.

3. Device according to claim **1**, wherein the first actuator is configured to move the mechanical cleaning member inside the cleaning chamber with a reciprocating movement.

4. Device according to claim **1**, wherein the first actuator is configured to move the mechanical cleaning member inside the cleaning chamber with a reciprocating movement parallel to the roller axis.

5. Device according to claim **1**, wherein said mechanical cleaning member is provided with a movement, with respect to the cleaning chamber, toward or away from the roller.

6. Device according to claim **1**, wherein the lateral sealing gaskets are elastically yielding to adapt to the cylindrical side surface of the roller to be cleaned.

7. Device according to claim **1**, wherein the lateral sealing gaskets are housed in respective side elements, said side elements being adapted to house lateral sealing gaskets of variable dimensions, as a function of a diameter of said roller to be cleaned.

8. Device according to claim **7**, wherein the side elements are adapted to house lateral sealing gaskets replaceable to

cover a range of diameters of the roller to be cleaned comprised between 150 and 220 mm, or between 220 and 300 mm.

9. Device according to claim **7**, wherein the sealing blades are held with pressure on the roller to be cleaned through pressure members, and wherein the sealing blades are supported by said side elements.

10. Device according to claim **1**, wherein the cleaning chamber is made fluid tight, through a combination of said lateral sealing gaskets and of said sealing blades in cooperation with the cylindrical side surface of the roller to be cleaned.

11. Device according to claim **1**, wherein the concave edges of the lateral sealing gaskets comprise lateral chambers that are open toward the cylindrical side surface of the roller to be cleaned.

12. Device according to claim **11**, wherein nozzles for feeding a rinsing liquid open into the lateral chambers.

13. Device according to claim **1**, wherein the mechanical cleaning member comprises at least a brush.

14. Device according to claim **1**, wherein the mechanical cleaning member is divided into at least two parts separated along a channel parallel to the roller to be cleaned.

15. Device according to claim **1**, wherein the mechanical cleaning member has two active surfaces adapted to act on the roller to be cleaned, which are mutually inclined to form a V-shaped surface with the vertex oriented toward the inside of the cleaning chamber.

16. The cleaning machine of claim **1**, wherein the cleaning head is configured to be actuated independent of actuation of the mechanical cleaning member, and wherein no portion of the mechanical cleaning member extends outside of the cleaning head.

17. The cleaning device of claim **1**, wherein the lateral sealing gaskets are replaceable as a function of the diameter of the roller to be cleaned.

18. A method for cleaning a first roller, comprising the following steps:

providing a cleaning device according to claim **1**;

moving the cleaning head toward a lateral cylindrical surface of the first roller;

bringing the mechanical cleaning member into contact with the lateral cylindrical surface of the first roller to be cleaned;

moving the mechanical cleaning member with respect to the lateral cylindrical surface of the first roller while the mechanical cleaning element is in contact with the lateral cylindrical surface of the first roller; and

dispensing cleaning liquid into the cleaning chamber.

19. The method of the claim **18**, wherein the step of moving the mechanical cleaning member in contact with the lateral cylindrical surface of the first roller comprises a step of translating the mechanical cleaning member with alternating movement parallel to a longitudinal axis of the first roller.

20. The method of claim **18**, further comprising a step of rotating the first roller about a longitudinal axis of the first roller while the mechanical cleaning member acts on the lateral cylindrical surface of the first roller.

21. The method of the claim **18**, further comprising a step of gradually translating the cleaning head along a longitudinal axis of the first roller to clean the whole lateral cylindrical surface of the first roller.

22. A cleaning machine comprising:

a supporting structure;

on said supporting structure, supporting devices for supporting a cylindrical roller to be cleaned, wherein the cylindrical roller comprises a longitudinal roller axis and a cylindrical side surface;

a driving unit adapted to drive the roller into rotation when the roller is supported on the supporting devices;

a cleaning device comprising:

a cleaning head with a cleaning chamber;

sealing blades extending parallel to the roller axis and lateral sealing gaskets extending transversely to the roller axis, the sealing blades and the lateral sealing gaskets closing the cleaning chamber, the lateral sealing gaskets having concave edges configured to sealingly contact the cylindrical side surface of the roller;

a mechanical cleaning member housed in the cleaning chamber;

a first actuator configured to move the mechanical cleaning member inside the cleaning chamber;

cleaning liquid feeding members configured to feed a cleaning liquid into the cleaning chamber, wherein the mechanical cleaning member and the cleaning liquid fed by the feeding members work in combination inside the cleaning chamber, the cleaning head being provided with a translation movement in a direction parallel to the roller axis of the cylindrical roller, the first actuator being configured to move the mechanical cleaning member with respect to the cleaning chamber while maintaining the mechanical cleaning member in contact with the cylindrical side surface of the roller.

23. The cleaning machine of claim **22**, further comprising wheels adapted to displace the cleaning machine.

24. The cleaning machine of claim **22**, wherein the driving unit comprises a rotating spindle adapted to selectively engage and disengage the roller and a magnetic engaging device to torsionally connect the spindle to the roller.

25. The cleaning machine of claim **22**, wherein the cleaning head is configured to be actuated independent of actuation of the mechanical cleaning member, and wherein no portion of the mechanical cleaning member extends outside of the cleaning head.

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